USDA FOREST SERVICE GENERAL TECHNICAL REPORT PNW-115
1981

CTIONS OF FIRE BEHAVIOR AND TANCE TO CONTROL

E WITH PHOTO SERIES FOR THE OSA PINE TYPE, PONDEROSA PINE AND ATED SPECIES TYPE, AND LODGEPOLE PINE TYPE

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ACKNOWLEDGMENT: This publication was developed by the Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, in cooperation with the Bureau of Land Management, U.S. Department of the Interior; Washington State Department of Natural Resources; State of Oregon Forestry Department; and USDA Forest Service, Pacific Northwest Region, to serve the needs of forest land managers in the Pacific Northwest.

Abstract

This publication presents tables on the behavior of fire and the resistance of fuels to control. The information is to be used with the publication, "Photo Series for Quantifying Forest Residues in the Ponderosa Pine Type, Ponderosa Pine and Associated Species Type, Lodgepole Pine Type" (USDA For. Serv. Gen. Tech. Rep. PNW-52, 1976, by Wayne G. Maxwell and Franklin R. Ward).

KEYWORDS: Fire behavior (forest), fire management, fire spread.

Metric Conversion

To change	to	multiply by:
Miles per hour	kilometers per hour	1.6093
Chains	meters	20.12
Feet	meters	0.3048
Acres	hectares	0.4047

Species List

Douglas-fir	Pseudotsuga menziesii (Mirb.) Franco
ponderosa pine	Pinus ponderosa Dougl. ex Laws.
lodgepole pine	Pinus contorta Dougl. ex Loud.

Timber harvest and silvicultural practices--as well as natural phenomena, such as windthrow, ice damage, and wildfire--often leave undesirable amounts of forest residues. The forest manager must set limits on the amount of residues and fire hazard that are consistent with resource management objectives.

Photo series have been published as an inventory tool to assess fuel loadings by size class in several forest types. The photos are used to translate visual images to quantities (tons per acre) so the manager can describe the residue that should be retained to meet environmental concerns and goals of a particular specialty. The photos also provide a starting point for assessing fire hazard.

This publication presents tables for predicting rate of fire spread, flame length, and resistance of fuel to control for each residue condition depicted by the photo series for the ponderosa pine, ponderosa pine and associated species, and lodgepole pine types (Maxwell and Ward 1976). Fire behavior estimates are based solely on measured fuel loadings in the 1/4- to 3-inch diameter range. All other inputs to a mathematical fire spread model (Rothermel 1972), including depth of fuel bed and 1-hour timelag (0- to 1/4-inch diameter) loading, are generated by assuming similarity of the fuel bed to a stylized fuel model. Packing and surface-to-volume ratios were derived by interpolation between models. Foliage and litter loadings are reflected in the 1-hour timelag fuel loading. No live or coarse (greater than 3-inch diameter) fuels are considered.

Two sets of fuel models are in widespread use for fire planning and hazard appraisal--Northern Forest Fire Laboratory (NFFL) and National Fire-Danger Rating (NFDR) models. The NFFL models (Albini 1976) are also used for forecasting behavior of wildfire. Generally, the slash fuel models reflect an average of typical fuel conditions in Douglas-fir and ponderosa pine slash. The NFDR models (Deeming et al. 1977) differ from the NFFL series mainly in that a greater proportion of 1-hour timelag fuels are present relative to 10- and 100-hour fuels (1/4 inch to 3 inches). Packing ratios are similar, but NFFL models have more nearly optimum packing. Because of these differences, predictions for spread and intensity of fire for fuels with properties of the NFDR slash models will be slightly greater at low windspeeds--and much greater at high windspeeds--than fuels with the physical properties of NFFL slash models.

A choice between using the NFFL or NFDR series of models to represent the fuel bed in a photo from Maxwell and Ward (1976) was based on the proportion of fine fuels present and on the believability of the output on fire behavior. Residues from second-growth timber and red slash, because of a greater amount of 1-hour fuel loading, are better represented by NFDR models. Old-growth or overwintered slash has characteristics similar to NFFL models.

Rothermel's (1972) fire spread model is the basis for estimates of fire behavior. The algorithm used to estimate flame lengths for photographs judged similar to NFDR fuel models is the same used in the NFDR system. The fire spread model, however, depends on a continuous and homogeneous fuel bed, and adjustments are needed if those conditions do not prevail. Several fuel beds depicted in the photo series by Maxwell and Ward (1976) were treated by fire or mechanical crushing. Where a treatment drastically reduced depth or continuity of the fuel bed, outputs of the model were adjusted accordingly.

Tables 1-27 provide a means to quantify relative differences in fire potential between fuel beds in a manner consistent with, but more precisely than, stylized fuel models. The user should not expect predicted values to be exact estimates of fire behavior on an actual fire on a specific unit. Deviations from one-half to two times the predicted values can be expected. Even values one-fourth to four times the actual value may occur. Deviations are also possible if the fuel inventory is inaccurate or if the character of the fuel bed is substantially different from the stylized fuel model.

Spread of fire is amplified by wind and slope. Effective wind (Albini 1976) is the windspeed that alone would produce the same amplification as the combined effects of wind and slope. The tables show effective wind at midflame height. Figure 1 can be used to determine effective midflame windspeed.

Fuel moisture content is calculated by combining the three fine fuel classes so that:

$$\begin{aligned}\text{Moisture content} = {} & 0.76 \times (\text{1-hour timelag moisture}) \\ & +0.18 \times (\text{10-hour timelag moisture}) \\ & +0.06 \times (\text{100-hour timelag moisture}).\end{aligned}$$

Fire perimeter, area, and resistance to control are also useful for fire planning. Formula and graphic aids (Fire Behavior Officer's Field Reference[1]) for determining perimeter and area are presented in appendix 1. Fuel resistance to control rating, slope, and flame length adjustment factors, and

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[1]National Interagency Fire Training Center, Marana, Arizona, 1978.

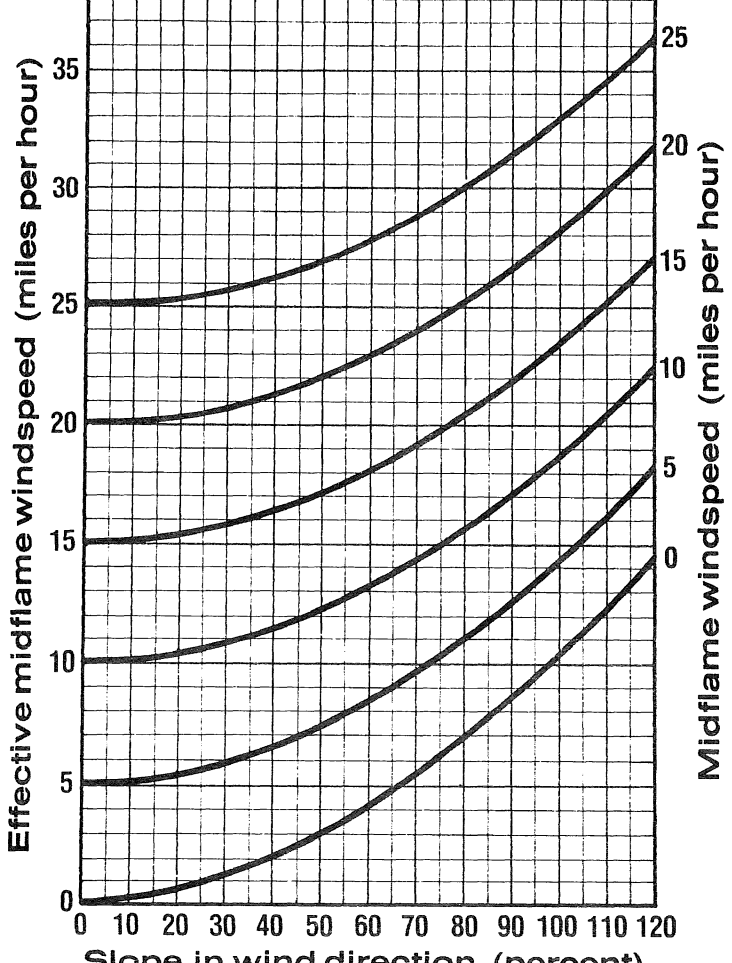

Figure 1.--Chart for determining effective windspeed from midflame windspeed and ground slope in direction of wind.

conversion of resistance to control rating values to chains per hour of line constructed by one person are presented in appendix 2.

For the approximate potential fire behavior and resistance of fuel to control for a particular area and given weather conditions, determine the following:

1. Which photo nearly matches, or which photos bracket, the area.
2. Rate of spread of fire and flame length (tables 1-27).
3. Perimeter and area of fire (from graphs and formulas in appendix 1).
4. Resistance of fuel to control (from tables in appendix 2).

For example, if the area was represented by photo 1-PP-4-CC in Maxwell and Ward (1976) and there was a 5-mi/h wind at midflame height, a fine fuel moisture of 4 percent, and the area was on a 20-percent slope, the following conditions would exist:

Effective midflame wind (miles per hour)--6
Rate of spread (chains per hour)--16
Flame length (feet)--9
Perimeter growth at 1 hour (chains)--46.9
Area at 1 hour (acres)--13.3
Resistance to suppression (chains/person-hour)--3.0

If the area was bracketed by two photos, interpolate by using the respective tables.

Literature Cited

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Ponderosa Pine

Size Class 4

Clearcut

Tables 1 Through 2

(Corresponds to Photo Series 1-PP-4-CC to 2-PP-4-CC in Maxwell and Ward 1976)

(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	2	6	13	20	28	37	46	61	86	3	6	8	10	12	14	15	17	20
3	1	6	11	18	25	33	41	54	76	3	5	8	9	11	12	14	15	18
4	1	5	10	16	22	29	36	48	68	3	5	7	8	10	11	12	14	17
5	1	5	9	14	20	26	33	43	61	2	5	6	8	9	10	11	13	15
6	1	4	8	13	19	24	30	39	56	2	4	6	7	8	9	10	12	14
7	1	4	8	12	17	22	28	37	52	2	4	5	7	8	9	10	11	13
8	1	4	7	11	16	21	26	34	49	2	4	5	6	7	8	9	10	12
9	1	3	7	11	15	20	25	32	46	2	3	5	6	7	8	8	9	11
10	1	3	7	10	14	19	24	31	44	2	3	4	5	6	7	8	9	10
11	1	3	6	10	14	18	23	30	42	2	3	4	5	6	7	7	8	10
12	1	3	6	10	13	17	22	28	40	1	3	4	5	5	6	7	8	9
13	1	3	6	9	13	17	21	27	39	1	3	4	4	5	6	6	7	9
14	1	3	6	9	12	16	20	26	37	1	2	3	4	5	5	6	7	8
15	1	3	5	8	12	15	19	25	36	1	2	3	4	4	5	6	6	7
16	1	2	5	8	11	15	18	24	34	1	2	3	3	4	5	5	6	7
17	1	2	5	8	11	14	17	23	32	1	2	3	3	4	4	5	5	6
18	1	2	4	7	10	13	16	21	30	1	2	2	3	3	4	4	5	6
19	1	2	4	6	9	12	14	19	27	1	1	2	3	3	3	4	4	5
20	0	2	4	6	8	10	13	17	24	1	1	2	2	3	3	3	4	4
21	0	1	3	5	7	9	11	14	20	1	1	1	2	2	2	3	3	3
22	0	1	2	4	5	7	9	11	16	0	1	1	1	2	2	2	2	3
23	0	1	2	3	4	5	6	8	11	0	1	1	1	1	1	1	2	2
24	0	0	1	1	2	3	3	4	6	0	0	0	1	1	1	1	1	1

E 2--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 2-PP-4-CC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

TURE	RATE OF SPREAD									FLAME LENGTH									
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)									
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ENT	CHAINS PER HOUR									FEET									
	3	9	19	30	42	54	67	88	126	5	9	12	15	17	20	22	25	29
	2	8	17	26	37	48	59	78	111	4	8	11	14	16	18	20	22	26
	2	7	15	23	33	43	53	70	99	4	7	10	12	14	16	18	20	24
	2	7	13	21	30	39	48	63	89	4	7	9	11	13	15	16	19	22
	2	6	12	19	27	35	44	58	82	3	6	8	10	12	14	15	17	20
	2	6	11	18	25	33	41	53	76	3	6	8	10	11	13	14	16	19
	1	5	11	17	23	31	38	50	71	3	5	7	9	10	12	13	15	17
	1	5	10	16	22	29	36	47	67	3	5	7	8	10	11	12	14	16
	1	5	10	15	21	28	34	45	64	3	5	6	8	9	10	11	13	15
	1	5	9	14	20	26	33	43	61	2	4	6	7	8	10	11	12	14
	1	4	9	14	19	25	32	41	59	2	4	6	7	8	9	10	11	13
	1	4	9	13	19	24	30	40	57	2	4	5	6	7	8	9	10	12
	1	4	8	13	18	24	29	38	55	2	3	5	6	7	8	9	10	11
	1	4	8	12	17	23	28	37	52	2	3	4	5	6	7	8	9	11
	1	4	7	12	16	21	27	35	50	2	3	4	5	6	7	7	8	10
	1	3	7	11	15	20	25	33	47	1	3	4	5	5	6	7	8	9
	1	3	6	10	14	19	23	30	43	1	2	3	4	5	5	6	7	8
	1	3	6	9	13	17	21	28	39	1	2	3	4	4	5	5	6	7
	1	3	5	8	11	15	19	24	35	1	2	3	3	4	4	5	5	6
	1	2	4	7	10	13	16	21	29	1	2	2	3	3	3	4	4	5
	0	2	4	6	8	10	13	16	23	1	1	2	2	2	3	3	3	4
	0	1	2	4	5	7	9	12	17	0	1	1	1	2	2	2	2	3
	0	1	1	2	3	4	5	6	9	0	0	1	1	1	1	1	1	2

Ponderosa Pine

Size Class 4

Partial Cut

Tables 3 Through 7

(Corresponds to Photo Series 1-PP-4-PC to 5-PP-4-PC in Maxwell and Ward 1976)

BLE 3--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 1-PP-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	1	2	3	4	6	7	9	12	0	1	1	1	1	2	2	2	2
3	0	1	2	3	4	5	6	8	10	0	1	1	1	1	1	2	2	2
4	0	1	2	2	3	4	5	7	9	0	1	1	1	1	1	1	2	2
5	0	1	1	2	3	4	5	6	9	0	1	1	1	1	1	1	2	2
6	0	1	1	2	3	4	5	6	8	0	1	1	1	1	1	1	1	2
7	0	1	1	2	3	3	4	6	8	0	1	1	1	1	1	1	1	2
8	0	1	1	2	3	3	4	5	7	0	0	1	1	1	1	1	1	2
9	0	1	1	2	2	3	4	5	7	0	0	1	1	1	1	1	1	1
10	0	0	1	1	2	3	3	4	6	0	0	1	1	1	1	1	1	1
11	0	0	1	1	1	2	2	3	4	0	0	0	1	1	1	1	1	1
12	0	0	0	1	1	1	1	2	2	0	0	0	0	0	0	0	0	1

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	4	9	14	19	25	31	41	58	2	4	5	7	8	9	10	11	13
3	1	4	8	12	17	22	27	36	51	2	4	5	6	7	8	9	10	12
4	1	3	7	11	15	20	24	32	46	2	3	5	6	7	7	8	9	11
5	1	3	6	10	14	18	22	29	41	2	3	4	5	6	7	8	9	10
6	1	3	6	9	12	16	20	27	38	1	3	4	5	6	6	7	8	9
7	1	3	5	8	11	15	19	25	35	1	3	4	4	5	6	6	7	9
8	1	2	5	8	11	14	18	23	33	1	2	3	4	5	5	6	7	8
9	1	2	5	7	10	13	17	22	31	1	2	3	4	4	5	6	6	7
10	1	2	4	7	10	13	16	21	30	1	2	3	4	4	5	5	6	7
11	0	2	4	7	9	12	15	20	28	1	2	3	3	4	4	5	5	6
12	0	2	4	6	9	12	15	19	27	1	2	3	3	4	4	5	5	6
13	0	2	4	6	9	11	14	18	26	1	2	2	3	3	4	4	5	6
14	0	2	4	6	8	11	13	18	25	1	2	2	3	3	4	4	4	5
15	0	2	4	6	8	10	13	17	24	1	1	2	2	3	3	4	4	5
16	0	2	3	5	8	10	12	16	23	1	1	2	2	3	3	3	4	4
17	0	2	3	5	7	9	12	15	22	1	1	2	2	2	3	3	3	4
18	0	1	3	5	7	9	11	14	20	1	1	2	2	2	2	3	3	4
19	0	1	3	4	6	8	10	13	18	0	1	1	2	2	2	2	3	3
20	0	1	2	4	5	7	9	11	16	0	1	1	1	2	2	2	2	3
21	0	1	2	3	4	6	7	10	14	0	1	1	1	1	2	2	2	2
22	0	1	2	3	4	5	6	8	11	0	1	1	1	1	1	1	2	2
23	0	1	1	2	2	3	4	5	8	0	0	1	1	1	1	1	1	1
24	0	0	1	1	1	2	2	3	4	0	0	0	0	0	0	1	1	1

TABLE 5--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 3-PP-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	5	8	11	14	17	22	30	1	2	3	4	4	5	5	6	7
3	0	2	4	7	9	12	15	19	26	1	2	3	3	4	4	5	5	6
4	0	2	4	6	8	11	13	17	23	1	2	3	3	4	4	4	5	6
5	0	2	4	6	8	10	12	15	21	1	2	2	3	3	4	4	5	5
6	0	2	3	5	7	9	11	14	20	1	2	2	3	3	4	4	4	5
7	0	2	3	5	7	9	11	14	19	1	2	2	3	3	3	4	4	5
8	0	2	3	5	6	8	10	13	18	1	2	2	3	3	3	4	4	5
9	0	1	3	4	6	8	9	12	17	1	1	2	2	3	3	3	4	5
10	0	1	3	4	5	7	8	11	15	1	1	2	2	3	3	3	4	4
11	0	1	2	3	5	6	7	9	13	1	1	2	2	2	3	3	3	4
12	0	1	2	3	4	5	6	7	10	0	1	1	2	2	2	2	3	3
13	0	1	1	2	2	3	3	4	6	0	1	1	1	1	1	1	2	2
14	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	5	9	15	21	27	34	45	64	2	4	6	7	8	9	10	12	14
3	1	4	8	13	19	24	30	40	56	2	4	5	6	8	8	9	11	13
4	1	4	7	12	17	22	27	35	50	2	3	5	6	7	8	9	10	11
5	1	3	7	11	15	19	24	32	45	2	3	4	5	6	7	8	9	10
6	1	3	6	10	14	18	22	29	42	2	3	4	5	6	7	7	8	10
7	1	3	6	9	13	17	21	27	38	1	3	4	5	5	6	7	8	9
8	1	3	5	8	12	15	19	25	36	1	2	3	4	5	6	6	7	8
9	1	2	5	8	11	15	18	24	34	1	2	3	4	5	5	6	7	9
10	1	2	5	8	11	14	17	23	32	1	2	3	4	4	5	5	6	7
11	1	2	5	7	10	13	17	22	31	1	2	3	3	4	5	5	6	7
12	1	2	4	7	10	13	16	21	30	1	2	3	3	4	4	5	5	6
13	1	2	4	7	9	12	15	20	29	1	2	2	3	4	4	4	5	6
14	0	2	4	7	9	12	15	19	28	1	2	2	3	3	4	4	5	5
15	0	2	4	6	9	11	14	19	27	1	2	2	3	3	3	4	4	5
16	0	2	4	6	8	11	14	18	25	1	1	2	2	3	3	3	4	5
17	0	2	4	6	8	10	13	17	24	1	1	2	2	3	3	3	4	4
18	0	2	3	5	7	9	12	15	22	1	1	2	2	2	3	3	3	4
19	0	1	3	5	7	9	11	14	20	1	1	1	2	2	2	3	3	3
20	0	1	3	4	6	8	9	12	18	0	1	1	1	2	2	2	2	3
21	0	1	2	4	5	6	8	11	15	0	1	1	1	1	2	2	2	2
22	0	1	2	3	4	5	6	8	12	0	1	1	1	1	1	1	2	2
23	0	1	1	2	3	4	4	6	8	0	0	1	1	1	1	1	1	1
24	0	0	1	1	1	2	2	3	4	0	0	0	0	0	0	1	1	1

TABLE 7--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 5-PP-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	6	10	13	17	21	27	37	1	3	4	5	6	6	7	8	9
3	1	3	6	8	12	15	18	23	32	1	3	4	4	5	6	6	7	8
4	1	3	5	8	10	13	16	21	28	1	2	3	4	5	5	6	6	7
5	1	2	4	7	9	12	15	19	26	1	2	3	4	4	5	5	6	7
6	0	2	4	6	9	11	14	18	24	1	2	3	4	4	5	5	6	7
7	0	2	4	6	8	11	13	17	23	1	2	3	3	4	4	5	5	6
8	0	2	4	6	8	10	12	16	22	1	2	3	3	4	4	5	5	6
9	0	2	4	5	7	10	12	15	21	1	2	3	3	4	4	5	5	6
10	0	2	3	5	7	9	11	14	19	1	2	2	3	3	4	4	5	6
11	0	2	3	4	6	8	10	12	17	1	2	2	3	3	4	4	4	5
12	0	1	2	4	5	6	8	10	14	1	1	2	2	3	3	3	4	4
13	0	1	2	3	4	5	6	7	10	1	1	1	2	2	2	3	3	3
14	0	0	1	1	2	3	3	4	6	0	1	1	1	1	1	1	2	2

Ponderosa Pine

Size Class 1

Precommercial Thinning

Tables 8 Through 13

(Corresponds to Photo Series 1-PP-1-TH to 6-PP-1-TH in Maxwell and Ward 1976)

TABLE 8--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 1-PP-1-TH
(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	5	10	16	23	29	37	48	69	2	4	6	7	8	10	11	12	14
3	1	4	9	14	20	26	32	42	60	2	4	5	7	8	9	10	11	13
4	1	4	8	13	18	23	29	38	54	2	4	5	6	7	8	9	10	12
5	1	4	7	11	16	21	26	34	49	2	3	4	6	6	7	8	9	11
6	1	3	7	10	15	19	24	31	45	2	3	4	5	6	7	7	8	10
7	1	3	6	10	14	18	22	29	41	1	3	4	5	5	6	7	8	9
8	1	3	6	9	13	17	21	27	39	1	3	4	4	5	6	6	7	9
9	1	3	5	9	12	16	20	26	37	1	2	3	4	5	5	6	7	8
10	1	3	5	8	11	15	19	24	35	1	2	3	4	4	5	6	6	7
11	1	2	5	8	11	14	18	23	33	1	2	3	4	4	5	5	6	7
12	1	2	5	8	11	14	17	23	32	1	2	3	3	4	4	5	6	6
13	1	2	5	7	10	13	17	22	31	1	2	3	3	4	4	5	5	6
14	1	2	4	7	10	13	16	21	30	1	2	2	3	3	4	4	5	6
15	1	2	4	7	9	12	15	20	28	1	2	2	3	3	4	4	4	5
16	0	2	4	6	9	12	14	19	27	1	1	2	2	3	3	4	4	5
17	0	2	4	6	8	11	14	18	25	1	1	2	2	3	3	3	4	4
18	0	2	3	6	8	10	13	17	24	1	1	2	2	2	3	3	3	4
19	0	2	3	5	7	9	11	15	21	1	1	1	2	2	2	3	3	3
20	0	1	3	4	6	8	10	13	19	0	1	1	2	2	2	2	3	3
21	0	1	2	4	5	7	9	11	16	0	1	1	1	1	2	2	2	2
22	0	1	2	3	4	5	7	9	13	0	1	1	1	1	1	1	2	2
23	0	1	1	2	3	4	5	6	9	0	0	1	1	1	1	1	1	1
24	0	0	1	1	2	2	3	3	5	0	0	0	0	0	0	1	1	1

(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	5	10	17	23	30	38	50	71	3	5	7	8	10	11	12	14	16
3	1	5	9	15	20	27	33	44	62	2	4	6	7	9	10	11	12	14
4	1	4	8	13	18	24	30	39	56	2	4	5	7	8	9	10	11	13
5	1	4	7	12	17	22	27	35	50	2	4	5	6	7	8	9	10	12
6	1	3	7	11	15	20	25	32	46	2	3	5	6	7	8	8	9	11
7	1	3	6	10	14	18	23	30	42	2	3	4	5	6	7	8	9	10
8	1	3	6	9	13	17	21	28	40	2	3	4	5	6	6	7	8	10
9	1	3	6	9	12	16	20	26	38	1	3	4	5	5	6	7	8	9
10	1	3	5	8	12	15	19	25	36	1	2	3	4	5	6	6	7	8
11	1	2	5	8	11	15	18	24	34	1	2	3	4	5	5	6	7	8
12	1	2	5	8	11	14	18	23	33	1	2	3	4	4	5	5	6	7
13	1	2	5	7	10	14	17	22	32	1	2	3	3	4	5	5	6	7
14	1	2	5	7	10	13	16	22	31	1	2	3	3	4	4	5	5	6
15	1	2	4	7	10	13	16	21	29	1	2	2	3	4	4	4	5	6
16	1	2	4	7	9	12	15	20	28	1	2	2	3	3	4	4	5	5
17	0	2	4	6	9	11	14	18	26	1	1	2	3	3	3	4	4	5
18	0	2	4	6	8	10	13	17	24	1	1	2	2	3	3	3	4	4
19	0	2	3	5	7	9	12	16	22	1	1	2	2	2	3	3	3	4
20	0	1	3	5	6	8	10	14	20	1	1	1	2	2	2	3	3	3
21	0	1	2	4	5	7	9	12	17	0	1	1	1	2	2	2	2	3
22	0	1	2	3	4	6	7	9	13	0	1	1	1	1	1	2	2	2
23	0	1	1	2	3	4	5	6	9	0	0	1	1	1	1	1	1	2
24	0	0	1	1	2	2	3	3	5	0	0	0	0	0	1	1	1	1

TABLE 10--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 3-PP-1-TH
(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	5	11	17	24	31	39	51	72	3	6	8	9	11	12	14	16	18
3	1	5	9	15	21	27	34	45	64	3	5	7	9	10	11	13	14	17
4	1	4	8	13	19	24	30	40	57	2	5	6	8	9	10	11	13	15
5	1	4	8	12	17	22	28	36	51	2	4	6	7	8	9	10	12	14
6	1	3	7	11	15	20	25	33	47	2	4	5	7	8	9	10	11	13
7	1	3	6	10	14	19	23	31	44	2	4	5	6	7	8	9	10	12
8	1	3	6	10	13	18	22	29	41	2	3	5	6	7	7	8	9	11
9	1	3	6	9	13	17	21	27	39	2	3	4	5	6	7	8	9	10
10	1	3	5	9	12	16	20	26	37	2	3	4	5	6	7	7	8	10
11	1	3	5	8	12	15	19	25	35	1	3	4	5	5	6	7	8	9
12	1	2	5	8	11	15	18	24	34	1	3	3	4	5	6	6	7	8
13	1	2	5	8	11	14	17	23	33	1	2	3	4	5	5	6	7	8
14	1	2	5	7	10	13	17	22	31	1	2	3	4	4	5	5	6	7
15	1	2	4	7	10	13	16	21	30	1	2	3	3	4	5	5	6	7
16	1	2	4	7	9	12	15	20	29	1	2	3	3	4	4	5	5	6
17	0	2	4	6	9	12	14	19	27	1	2	2	3	3	4	4	5	6
18	0	2	4	6	8	11	13	18	25	1	2	2	3	3	3	4	4	5
19	0	2	3	5	7	10	12	16	23	1	1	2	2	3	3	3	4	4
20	0	1	3	5	7	9	11	14	20	1	1	2	2	2	3	3	3	4
21	0	1	3	4	6	7	9	12	17	1	1	1	2	2	2	2	3	3
22	0	1	2	3	4	6	7	9	13	0	1	1	1	2	2	2	2	3
23	0	1	1	2	3	4	5	7	9	0	1	1	1	1	1	1	2	2
24	0	0	1	1	2	2	3	4	5	0	0	0	0	1	1	1	1	1

ABLE 11 FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 4-PP-1-TH
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

UEL OISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ERCENT	CHAINS PER HOUR									FEET								
2	0	2	5	7	10	12	15	20	27	1	2	3	3	4	4	5	5	6
3	0	2	4	6	8	11	13	17	23	1	2	2	3	3	4	4	5	5
4	0	2	4	5	7	9	12	15	21	1	2	2	3	3	3	4	4	5
5	0	2	3	5	7	9	11	14	19	1	2	2	3	3	3	4	4	5
6	0	2	3	5	6	8	10	13	18	1	1	2	2	3	3	3	4	4
7	0	1	3	4	6	8	9	12	17	1	1	2	2	3	3	3	4	4
8	0	1	3	4	6	7	9	12	16	1	1	2	2	3	3	3	4	4
9	0	1	3	4	5	7	8	11	15	1	1	2	2	2	3	3	3	4
10	0	1	2	3	5	6	7	10	13	1	1	2	2	2	3	3	3	4
11	0	1	2	3	4	5	6	8	11	0	1	1	2	2	2	2	3	3
12	0	1	1	2	3	4	5	6	8	0	1	1	1	2	2	2	2	2
13	0	0	1	1	2	2	3	3	5	0	0	1	1	1	1	1	1	1

TABLE 12--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 5-PP-1-TH
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	4	8	13	17	22	27	34	47	2	4	5	7	8	8	9	10	12
3	1	4	7	11	15	19	23	30	41	2	4	5	6	7	8	8	9	11
4	1	3	6	10	13	17	20	26	36	2	3	4	5	6	7	7	8	10
5	1	3	6	9	12	15	19	24	33	2	3	4	5	6	6	7	8	9
6	1	3	5	8	11	14	17	22	31	1	3	4	5	5	6	7	7	9
7	1	3	5	8	10	13	16	21	29	1	3	4	5	5	6	6	7	8
8	1	2	5	7	10	13	16	20	28	1	3	4	4	5	6	6	7	8
9	1	2	5	7	10	12	15	19	26	1	3	4	4	5	6	6	7	8
10	1	2	4	7	9	11	14	18	25	1	2	3	4	5	5	6	7	8
11	0	2	4	6	8	11	13	17	23	1	2	3	4	4	5	5	6	7
12	0	2	4	5	7	9	11	15	20	1	2	3	4	4	5	5	6	6
13	0	2	3	5	6	8	10	12	17	1	2	2	3	3	4	4	5	6
14	0	1	2	3	5	6	7	9	13	1	1	2	2	3	3	3	4	4
15	0	1	1	2	3	3	4	5	7	0	1	1	1	2	2	2	2	3
16	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0

TABLE 13--FIRE BEHAVIOR AND CONTROL INFORMATION FOR FUEL B-PP-1-TH

(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	2	7	15	24	33	43	54	71	101	5	9	12	15	18	20	22	25	30
3	2	7	13	21	29	38	48	63	89	4	8	11	14	16	18	20	23	27
4	2	6	12	19	26	34	43	56	80	4	7	10	13	15	17	19	21	25
5	1	5	11	17	24	31	39	51	72	4	7	9	12	14	15	17	19	23
6	1	5	10	16	22	28	35	46	66	3	6	9	11	13	14	16	18	21
7	1	4	9	14	20	26	33	43	61	3	6	8	10	12	13	15	16	19
8	1	4	9	13	19	25	31	40	57	3	5	8	9	11	12	14	15	18
9	1	4	8	13	18	23	29	38	54	3	5	7	9	10	11	13	14	17
10	1	4	8	12	17	22	28	36	51	3	5	7	8	9	11	12	13	16
11	1	4	7	12	16	21	26	35	49	2	4	6	8	9	10	11	12	15
12	1	3	7	11	16	20	25	33	47	2	4	6	7	8	9	10	12	14
13	1	3	7	11	15	20	24	32	46	2	4	5	7	8	9	10	11	13
14	1	3	7	10	14	19	24	31	44	2	4	5	6	7	8	9	10	12
15	1	3	6	10	14	18	23	30	42	2	3	5	6	7	7	8	9	11
16	1	3	6	9	13	17	21	28	40	2	3	4	5	6	7	8	9	10
17	1	3	6	9	12	16	20	26	38	1	3	4	5	6	6	7	8	9
18	1	3	5	8	11	15	19	25	35	1	2	3	4	5	6	6	7	8
19	1	2	5	7	10	14	17	22	32	1	2	3	4	4	5	5	6	7
20	1	2	4	7	9	12	15	20	28	1	2	3	3	4	4	5	5	6
21	0	2	4	6	8	10	13	17	24	1	2	2	3	3	4	4	4	5
22	0	1	3	4	6	8	10	13	19	1	1	2	2	2	3	3	3	4
23	0	1	2	3	4	6	7	9	13	0	1	1	1	2	2	2	2	3
24	0	1	1	2	2	3	4	5	7	0	0	1	1	1	1	1	1	2

Ponderosa Pine and Associated Species

Size Class 4

Partial Cut

Tables 14 Through 21

(Corresponds to Photo Series 1-PP&ASSOC-4-PC to 8-PP&ASSOC-4-PC in Maxwell and Ward 1976)

(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	0	2	4	6	8	10	12	16	22	1	2	2	3	3	3	4	4	5
3	0	2	3	5	7	9	11	14	19	1	1	2	2	3	3	3	4	4
4	0	1	3	4	6	8	9	12	17	1	1	2	2	2	3	3	3	4
5	0	1	3	4	6	7	9	11	16	1	1	2	2	2	3	3	3	4
6	0	1	2	4	5	7	8	11	15	1	1	2	2	2	2	3	3	4
7	0	1	2	4	5	6	8	10	14	1	1	1	2	2	2	3	3	3
8	0	1	2	3	5	6	7	9	13	1	1	1	2	2	2	3	3	3
9	0	1	2	3	4	6	7	9	12	0	1	1	2	2	2	2	3	3
10	0	1	2	3	4	5	6	8	11	0	1	1	1	2	2	2	2	3
11	0	1	1	2	3	4	5	6	9	0	1	1	1	1	2	2	2	2
12	0	0	1	2	2	3	3	4	6	0	1	1	1	1	1	1	1	2
13	0	0	0	1	1	1	1	2	2	0	0	0	0	0	1	1	1	1

TABLE 15--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 2-PP&ASSOC-4-PC

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 16--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 3-PP&ASSOC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	6	8	12	15	18	23	32	1	2	3	4	5	5	6	6	8
3	1	2	5	7	10	13	15	20	28	1	2	3	4	4	5	5	6	7
4	0	2	4	6	9	11	14	18	24	1	2	3	3	4	4	5	5	6
5	0	2	4	6	8	10	13	16	22	1	2	3	3	4	4	4	5	6
6	0	2	4	6	8	10	12	15	21	1	2	2	3	3	4	4	5	5
7	0	2	3	5	7	9	11	14	20	1	2	2	3	3	4	4	5	5
8	0	2	3	5	7	9	11	14	19	1	2	2	3	3	4	4	4	5
9	0	2	3	5	6	8	10	13	18	1	2	2	3	3	3	4	4	5
10	0	1	3	4	6	7	9	12	16	1	1	2	2	3	3	4	4	5
11	0	1	2	4	5	6	8	10	14	1	1	2	2	3	3	3	3	4
12	0	1	2	3	4	5	6	8	11	1	1	1	2	2	2	3	3	3
13	0	1	1	2	3	3	4	5	7	0	1	1	1	1	2	2	2	2
14	0	0	0	1	1	1	1	2	2	0	0	0	0	0	1	1	1	1

TABLE 17--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 4-PP&ASSOC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	6	8	12	15	18	23	32	1	2	3	4	5	5	6	6	8
3	1	2	5	7	10	13	15	20	27	1	2	3	4	4	5	5	6	7
4	0	2	4	6	9	11	14	18	24	1	2	3	3	4	4	5	5	6
5	0	2	4	6	8	10	13	16	22	1	2	3	3	4	4	4	5	6
6	0	2	4	5	7	10	12	15	21	1	2	2	3	3	4	4	5	5
7	0	2	3	5	7	9	11	14	20	1	2	2	3	3	4	4	5	5
8	0	2	3	5	7	9	11	14	19	1	2	2	3	3	4	4	4	5
9	0	2	3	5	6	8	10	13	18	1	2	2	3	3	3	4	4	5
10	0	1	3	4	6	7	9	12	16	1	1	2	2	3	3	3	4	5
11	0	1	2	4	5	6	8	10	14	1	1	2	2	3	3	3	3	4
12	0	1	2	3	4	5	6	8	11	1	1	1	2	2	2	3	3	3
13	0	1	1	2	3	3	4	5	7	0	1	1	1	1	2	2	2	2
14	0	0	0	1	1	1	1	2	2	0	0	0	0	0	1	1	1	1

TABLE 18--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 5-PP&ASSOC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	5	8	10	13	16	21	29	1	2	3	4	4	5	5	6	7
3	0	2	4	7	9	11	14	18	25	1	2	3	3	4	4	5	5	6
4	0	2	4	6	8	10	12	16	22	1	2	2	3	3	4	4	5	5
5	0	2	3	5	7	9	11	15	20	1	2	2	3	3	4	4	4	5
6	0	2	3	5	7	9	11	14	19	1	2	2	3	3	3	4	4	5
7	0	2	3	5	6	8	10	13	18	1	2	2	3	3	3	4	4	5
8	0	1	3	4	6	8	10	12	17	1	1	2	2	3	3	3	4	5
9	0	1	3	4	6	7	9	12	16	1	1	2	2	3	3	3	4	4
10	0	1	2	4	5	7	8	10	14	1	1	2	2	2	3	3	3	4
11	0	1	2	3	4	6	7	9	12	1	1	2	2	2	2	3	3	3
12	0	1	2	2	3	4	5	7	9	0	1	1	1	2	2	2	2	3
13	0	0	1	1	2	3	3	4	5	0	1	1	1	1	1	1	1	2
14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

TABLE 19--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 6-PP&ASSOC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	6	9	13	16	20	25	35	1	3	4	5	5	6	6	7	8
3	1	3	5	8	11	14	17	22	30	1	2	3	4	5	5	6	6	7
4	1	2	5	7	10	12	15	19	27	1	2	3	4	4	5	5	6	7
5	0	2	4	6	9	11	14	18	24	1	2	3	3	4	4	5	5	6
6	0	2	4	6	8	10	13	16	23	1	2	3	3	4	4	5	5	6
7	0	2	4	6	8	10	12	16	22	1	2	3	3	4	4	4	5	6
8	0	2	4	5	7	9	12	15	21	1	2	3	3	4	4	4	5	6
9	0	2	3	5	7	9	11	14	19	1	2	2	3	3	4	4	5	5
10	0	2	3	5	6	8	10	13	18	1	2	2	3	3	4	4	4	5
11	0	1	3	4	6	7	9	11	16	1	2	2	2	3	3	4	4	5
12	0	1	2	3	5	6	7	9	13	1	1	2	2	2	3	3	3	4
13	0	1	2	2	3	4	5	6	9	0	1	1	2	2	2	2	2	3
14	0	0	1	1	1	2	2	3	4	0	0	1	1	1	1	1	1	1

TABLE 20--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 7-PP&ASSOC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	5	8	11	14	17	22	31	1	2	3	4	4	5	6	6	7
3	0	2	5	7	10	12	15	19	26	1	2	3	3	4	4	5	5	6
4	0	2	4	6	8	11	13	17	23	1	2	3	3	4	4	4	5	6
5	0	2	4	6	8	10	12	16	21	1	2	2	3	3	4	4	5	5
6	0	2	3	5	7	9	11	15	20	1	2	2	3	3	4	4	4	5
7	0	2	3	5	7	9	11	14	19	1	2	2	3	3	4	4	4	5
8	0	2	3	5	7	8	10	13	18	1	2	2	3	3	3	4	4	5
9	0	1	3	4	6	8	10	12	17	1	2	2	3	3	3	4	4	5
10	0	1	3	4	6	7	9	11	15	1	1	2	2	3	3	3	4	4
11	0	1	2	3	5	6	7	10	13	1	1	2	2	2	3	3	3	4
12	0	1	2	3	4	5	6	7	10	0	1	1	2	2	2	2	3	3
13	0	1	1	2	2	3	4	5	6	0	1	1	1	1	1	2	2	2
14	0	0	0	0	1	1	1	1	2	0	0	0	0	0	0	0	0	1

TABLE 21--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 8-PP&ASSOC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	5	10	16	22	28	35	47	66	3	5	7	9	11	12	13	15	18
3	1	4	9	14	19	25	31	41	58	3	5	7	8	10	11	12	14	16
4	1	4	8	12	17	22	28	37	52	2	4	6	8	9	10	11	13	15
5	1	3	7	11	16	20	25	33	47	2	4	6	7	8	9	10	12	14
6	1	3	6	10	14	19	23	30	43	2	4	5	6	8	8	9	11	13
7	1	3	6	9	13	17	21	28	40	2	3	5	6	7	8	9	10	12
8	1	3	6	9	12	16	20	26	37	2	3	4	6	6	7	8	9	11
9	1	3	5	8	12	15	19	25	35	2	3	4	5	6	7	8	9	10
10	1	2	5	8	11	14	18	24	34	1	3	4	5	6	6	7	8	9
11	1	2	5	8	11	14	17	23	32	1	3	4	4	5	6	7	7	9
12	1	2	5	7	10	13	17	22	31	1	2	3	4	5	6	6	7	8
13	1	2	4	7	10	13	16	21	30	1	2	3	4	5	5	6	7	8
14	1	2	4	7	9	12	15	20	29	1	2	3	4	4	5	5	6	7
15	0	2	4	6	9	12	15	19	28	1	2	3	3	4	4	5	6	7
16	0	2	4	6	9	11	14	18	26	1	2	3	3	4	4	5	5	6
17	0	2	4	6	8	11	13	17	25	1	2	2	3	3	4	4	5	6
18	0	2	3	5	8	10	12	16	23	1	1	2	3	3	3	4	4	5
19	0	2	3	5	7	9	11	15	21	1	1	2	2	3	3	3	4	4
20	0	1	3	4	6	8	10	13	18	1	1	2	2	2	3	3	3	4
21	0	1	2	4	5	7	8	11	16	0	1	1	2	2	2	2	3	3
22	0	1	2	3	4	5	7	9	12	0	1	1	1	1	2	2	2	2

Lodgepole Pine

Size Class 3

Clearcut

Table 22

(Corresponds to Photo Series 1-LP-3-CC in Maxwell and Ward 1976)

TABLE 22--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 1-LP-3-CC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	0	2	4	6	9	11	14	18	24	1	2	2	3	3	4	4	5	5
3	0	2	4	5	7	10	12	15	21	1	2	2	3	3	3	4	4	5
4	0	2	3	5	7	8	10	13	18	1	1	2	2	3	3	3	4	4
5	0	1	3	4	6	8	10	12	17	1	1	2	2	3	3	3	3	4
6	0	1	3	4	6	7	9	12	16	1	1	2	2	2	3	3	3	4
7	0	1	3	4	5	7	9	11	15	1	1	2	2	2	3	3	3	4
8	0	1	2	4	5	7	8	10	14	1	1	2	2	2	3	3	3	4
9	0	1	2	3	5	6	7	10	13	1	1	2	2	2	2	3	3	3
10	0	1	2	3	4	5	7	8	12	0	1	1	2	2	2	2	3	3
11	0	1	2	3	3	4	5	7	10	0	1	1	1	2	2	2	2	3
12	0	1	1	2	2	3	4	5	7	0	1	1	1	1	1	2	2	2
13	0	0	1	1	1	1	2	2	3	0	0	0	1	1	1	1	1	1

Lodgepole Pine

Size Class 3

Partial Cut

Tables 23 Through 27

(Corresponds to Photo Series 1-LP-3-PC to 5-LP-3-PC in Maxwell and Ward 1976)

TABLE 23--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 1-LP-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	0	1	3	4	5	7	8	11	15	0	1	1	2	2	2	2	3	3
3	0	1	2	3	5	6	7	9	13	0	1	1	1	2	2	2	2	3
4	0	1	2	3	4	5	6	8	11	0	1	1	1	1	2	2	2	2
5	0	1	2	3	4	5	6	8	11	0	1	1	1	1	2	2	2	2
6	0	1	2	3	4	5	6	7	10	0	1	1	1	1	2	2	2	2
7	0	1	2	2	3	4	5	7	9	0	1	1	1	1	1	2	2	2
8	0	1	1	2	3	4	5	6	9	0	1	1	1	1	1	2	2	2
9	0	1	1	2	3	4	5	6	8	0	1	1	1	1	1	1	2	2
10	0	1	1	2	2	3	4	5	7	0	1	1	1	1	1	1	1	2
11	0	0	1	1	2	2	3	4	5	0	0	1	1	1	1	1	1	1
12	0	0	1	1	1	1	2	2	3	0	0	0	0	1	1	1	1	1
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 24 FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 2-EP-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	0	2	5	7	10	12	15	19	27	1	2	3	3	4	4	5	5	6
3	0	2	4	6	8	10	13	16	23	1	2	2	3	3	4	4	5	5
4	0	2	3	5	7	9	11	15	20	1	2	2	3	3	3	4	4	5
5	0	2	3	5	7	9	10	13	19	1	1	2	2	3	3	3	4	5
6	0	2	3	5	6	8	10	13	17	1	1	2	2	3	3	3	4	4
7	0	1	3	4	6	8	9	12	17	1	1	2	2	3	3	3	4	4
8	0	1	3	4	6	7	9	11	16	1	1	2	2	3	3	3	4	4
9	0	1	2	4	5	7	8	11	15	1	1	2	2	2	3	3	3	4
10	0	1	2	3	5	6	7	9	13	1	1	2	2	2	2	3	3	4
11	0	1	2	3	4	5	6	8	11	0	1	1	2	2	2	2	3	3
12	0	1	1	2	3	4	5	6	8	0	1	1	1	1	2	2	2	2
13	0	0	1	1	2	2	2	3	4	0	0	1	1	1	1	1	1	1

TABLE 25--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 3-LP-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	4	8	13	18	23	29	38	54	2	4	6	7	8	9	10	12	14
3	1	3	7	11	16	21	26	34	48	2	4	5	6	7	8	9	11	12
4	1	3	6	10	14	18	23	30	43	2	3	5	6	7	8	8	10	11
5	1	3	6	9	13	17	21	27	39	2	3	4	5	6	7	8	9	10
6	1	3	5	8	12	15	19	25	35	1	3	4	5	6	6	7	8	10
7	1	2	5	8	11	14	17	23	33	1	3	4	5	5	6	7	8	9
8	1	2	5	7	10	13	16	21	31	1	2	3	4	5	6	6	7	8
9	1	2	4	7	9	12	15	20	29	1	2	3	4	5	5	6	6	8
10	0	2	4	6	9	12	15	19	28	1	2	3	4	4	5	5	6	7
11	0	2	4	6	9	11	14	19	26	1	2	3	3	4	5	5	6	7
12	0	2	4	6	8	11	14	18	25	1	2	3	3	4	4	5	5	6
13	0	2	4	6	8	11	13	17	24	1	2	2	3	3	4	4	5	6
14	0	2	3	6	8	10	13	17	24	1	2	2	3	3	4	4	5	5
15	0	2	3	5	7	10	12	16	23	1	1	2	3	3	3	4	4	5
16	0	2	3	5	7	9	11	15	21	1	1	2	2	3	3	3	4	5
17	0	1	3	5	7	9	11	14	20	1	1	2	2	3	3	3	4	4
18	0	1	3	4	6	8	10	13	19	1	1	2	2	2	3	3	3	4
19	0	1	3	4	6	7	9	12	17	1	1	1	2	2	2	2	3	3
20	0	1	2	4	5	6	8	11	15	0	1	1	1	2	2	2	2	3
21	0	1	2	3	4	5	7	9	13	0	1	1	1	1	2	2	2	2
22	0	1	1	2	3	4	5	7	10	0	1	1	1	1	1	1	2	2
23	0	1	1	2	2	3	4	5	7	0	0	1	1	1	1	1	1	1
24	0	0	1	1	1	2	2	3	4	0	0	0	0	0	0	1	1	1

(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	5	11	17	24	31	38	50	72	3	6	9	11	13	15	16	18	22
3	1	5	9	15	21	27	34	44	63	3	6	8	10	12	13	15	17	20
4	1	4	8	13	19	24	30	40	56	3	5	7	9	11	12	13	15	18
5	1	4	8	12	17	22	27	36	51	3	5	7	8	10	11	12	14	16
6	1	3	7	11	15	20	25	33	47	2	5	6	8	9	10	11	13	15
7	1	3	6	10	14	19	23	30	43	2	4	6	7	8	9	10	12	14
8	1	3	6	9	13	17	22	28	40	2	4	5	7	8	9	10	11	13
9	1	3	6	9	13	16	20	27	38	2	4	5	6	7	8	9	10	12
10	1	3	5	9	12	16	20	26	36	2	3	5	6	7	8	8	10	11
11	1	3	5	8	11	15	19	25	35	2	3	4	5	6	7	8	9	11
12	1	2	5	8	11	14	18	24	34	2	3	4	5	6	7	7	8	10
13	1	2	5	8	11	14	17	23	32	1	3	4	5	6	6	7	8	9
14	1	2	5	7	10	13	17	22	31	1	3	4	4	5	6	6	7	9
15	1	2	4	7	10	13	16	21	30	1	2	3	4	5	5	6	7	8
16	1	2	4	7	9	12	15	20	28	1	2	3	4	4	5	5	6	7
17	0	2	4	6	9	11	14	19	27	1	2	3	3	4	5	5	6	7
18	0	2	4	6	8	11	13	17	25	1	2	2	3	4	4	4	5	6
19	0	2	3	5	7	10	12	16	22	1	2	2	3	3	4	4	4	5
20	0	1	3	5	7	9	11	14	20	1	1	2	2	3	3	3	4	5
21	0	1	2	4	6	7	9	12	17	1	1	2	2	2	3	3	3	4
22	0	1	2	3	4	6	7	9	13	0	1	1	2	2	2	2	3	3
23	0	1	1	2	3	4	5	7	9	0	1	1	1	1	1	2	2	2
24	0	0	1	1	2	2	3	3	5	0	0	0	1	1	1	1	1	1

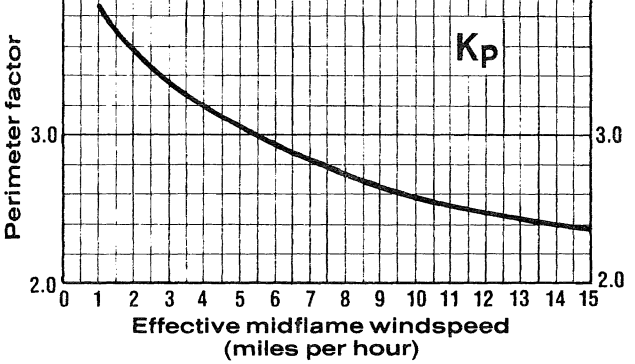
TABLE 27--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 5-LP-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

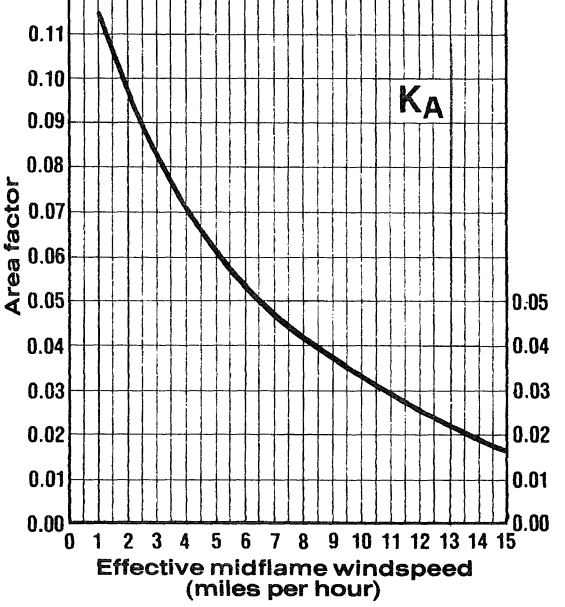
FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	5	8	11	14	18	23	31	1	2	3	4	5	5	6	6	7
3	0	2	5	7	10	12	15	19	27	1	2	3	3	4	4	5	6	6
4	0	2	4	6	9	11	13	17	24	1	2	3	3	4	4	4	5	6
5	0	2	4	6	8	10	12	16	22	1	2	2	3	3	4	4	5	5
6	0	2	3	5	7	9	11	15	20	1	2	2	3	3	4	4	5	5
7	0	2	3	5	7	9	11	14	19	1	2	2	3	3	4	4	4	5
8	0	2	3	5	7	8	10	13	18	1	2	2	3	3	3	4	4	5
9	0	2	3	5	6	8	10	12	17	1	2	2	3	3	3	4	4	5
10	0	1	3	4	6	7	9	11	16	1	1	2	2	3	3	3	4	4
11	0	1	2	4	5	6	8	10	13	1	1	2	2	2	3	3	3	4
12	0	1	2	3	4	5	6	8	11	0	1	1	2	2	2	2	3	3
13	0	1	1	2	2	3	4	5	7	0	1	1	1	1	1	2	2	2
14	0	0	0	0	1	1	1	1	2	0	0	0	0	0	0	0	1	1

Appendix 1

Fire Perimeter and Area Calculation Graphs and Formulas

(Adapted from Fire Behavior Officer's Field Reference, National Interagency Fire Training Center, Marana, Arizona)





P = Perimeter (chains)

$$P = K_P D$$
$$= K_P(RxT)$$

A = Area (acres)

$$A = K_A D^2$$
$$= K_A(RxT)^2$$

WHERE:

K_P = Perimeter factor
R = Rate of spread (chains per hour)
T = Time (hour); 1-hour maximum
K_A = Area factor
D = R x T; spread distance (chains)

Appendix 2

Resistance to control ratings, flame length adjustment factor, slope adjustment factor, and conversion of resistance to control rating values to chains per hour of line constructed by one person

The resistance to control rating (table 28) times flame length adjustment factor (table 29) times slope adjustment factor (table 30) equals the adjusted rating. Use table 31 to convert adjusted rating to actual resistance to control.

Table 28--Fuel resistance to control ratings by photo number[1]

PHOTO NUMBER	RATING	PHOTO NUMBER	RATING
1-PP-4-CC	5	1-PP&ASSOC-4-PC	4
2-PP-4-CC	8	2-PP&ASSOC-4-PC	3
		3-PP&ASSOC-4-PC	9
1-PP-4-PC	2	4-PP&ASSOC-4-PC	5
2-PP-4-PC	4	5-PP&ASSOC-4-PC	6
3-PP-4-PC	4	6-PP&ASSOC-4-PC	7
4-PP-4-PC	6	7-PP&ASSOC-4-PC	9
5-PP-4-PC	6	8-PP&ASSOC-4-PC	9
1-PP-1-TH	5	1-LP-3-CC	4
2-PP-1-TH	7		
3-PP-1-TH	8	1-LP-3-PC	2
4-PP-1-TH	6	2-LP-3-PC	4
5-PP-1-TH	6	3-LP-3-PC	4
6-PP-1-TH	9	4-LP-3-PC	6
		5-LP-3-PC	8

[1]Ratings derived from matrix by Wayne G. Maxwell (on file at Pacific Northwest Forest and Range Experiment Station, Portland, Oregon).

Table 29--Flame length adjustment factor

Flame length (feet)	0-4	5-8	9-12	13+
Adjustment factor	1	1.5	2.0	3.0

Table 30--Slope adjustment factor

Slope (percent)	0-30	31-60	61-75	75+
Adjustment factor	1	1.2	1.5	1.9

Adjusted rating values	Chains per hour	Adjusted rating values	Chains per hour
1	12.00	13	0.92
2	6.00	14	.86
3	4.00	15	.80
4	3.00	16	.75
5	2.40	17	.71
6	2.00	18	.67
7	1.70	19	.63
8	1.50	20	.60
9	1.30	25	.48
10	1.20	30	.40
11	1.10	35	.34
12	1.00	40	.30

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